Improving the automatic inversion of digital ISIS-2 ionogram reflection traces into topside vertical electron-density profiles

R.F. Benson, V. Truhlik, X. Huang, Y. Wang, and D. Bilitza

The topside-sounders on the four satellites of the International Satellites for Ionospheric Studies (ISIS) program were designed as analog systems. The resulting ionograms were displayed on 35-mm film for analysis by visual inspection. Each of these satellites, launched between 1962 and 1971, produced data for 10 to 20 years. A number of the original telemetry tapes from this large data set have been converted directly into digital records. Software, known as the TOPside Ionogram Scalar with True-height (TOPIST) algorithm has been produced that enables the automatic inversion of ISIS-2 ionogram reflection traces into topside vertical electron-density profiles Ne(h). More than ½ million digital Alouette/ISIS topside ionograms have been produced and over 300,000 are from ISIS 2. Many of these ISIS-2 ionograms correspond to a passive mode of operation for the detection of natural radio emissions and thus do not contain ionospheric reflection traces. TOPIST, however, is not able to produce Ne(h) profiles from all of the ISIS-2 ionograms with reflection traces because some of them did not contain frequency information. This information was missing due to difficulties encountered during the analog-to-digital conversion process in the detection of the ionogram frame-sync pulse and/or the frequency markers. Of the many digital topside ionograms that TOPIST was able to process, over 200 were found where direct comparisons could be made with Ne(h) profiles that were produced by manual scaling in the early days of the ISIS program. While many of these comparisons indicated excellent agreement (<10% average difference over the entire profile) there were also many cases with large differences (more than a factor of two). Here we will report on two approaches to improve the automatic inversion process: (1) improve the quality of the digital ionogram database by remedying the missing frequency-information problem when possible, and (2) using the above-mentioned comparisons as teaching examples of how to improve the original TOPIST software.